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THE BRITISH ASSOCIATION AT DUBLIN.

(Continued from page 116.*)*

WE now give notices of all the meteorological papers not reported in our last number. And we may preface them with two remarks—one a regret that we accidentally omitted from the list of observers present at the meeting one of the most able, viz., Mr. W. H. Wheeler, C.E., of Boston. As Mr. Wheeler contributed a valuable paper to the discussion on "River Administration," it is rather strange that we should have overlooked it. The other remark is that we hope that we shall not be held responsible for the report of the paper on "Rainbows." We did not hear it read, and we accurately reprint the only report of it which we have seen.

ON LIGHTNING CONDUCTORS AND ACCIDENTS BY LIGHTNING,

By RICHARD ANDERSON, F.C.S., M.S.T.E.

ONE hundred and twenty-six years have elapsed since Benjamin Franklin discovered, by means of his famous kite, that lightning could be drawn from the clouds, and its destructive qualities extinguished, by very simple means; and one hundred and ten years are gone by since the first of Franklin's "lightning rods" was set up for protection over the dome of England's metropolitan cathedral, St. Paul's. Yet so slow has been the "march of progress" in the application of one of the greatest scientific discoveries of modern times to the uses of daily life, that even now, after the lapse of more than a century, the employment of lightning conductors, simple as they are, and as inexpensive as simple, is far from being general, still less universal. At least one-half, and perhaps two-thirds, of all the public buildings, including the churches and chapels, of Great Britain and Ireland, are without protection against lightning. As to private houses, it is safe to assert that not five out of every hundred have lightning conductors. It is well known that the amount of property destroyed annually by lightning is very great, though it is naturally impossible to form any estimate of it. However, there are some facts as to the annual destruction of human life. According to the "Thirty-ninth Report of the Registrar-General," issued in July, 1878, and former reports, the number of deaths from lightning in England and Wales was as follows in each of the

eight years from 1869 to 1876, as given in the first portion of the following table :—

	England and Wales.			Prussia.		
Years.	Males.	Females.	Total.	Males.	Females.	Total.
1869	5	2	7	47	32	79
1870	13	6	19	59	43	102
1871	23	5	28	56	47	103
1872	35	11	46	50	35	85
1873	17	4	21	61	50	111
1874	25	—	25	52	41	93
1875	14	3	17	92	48	140
1876	15	4	19	59	47	106
Total	147	35	182	476	343	819

The returns from deaths by lightning given by the English Registrar General are admittedly incomplete. In Prussia, where the registration of the causes of death is under the enforcement of strict legal enactments, and, in consequence, far more accurate than in England, there were 819 persons reported as killed by lightning in the eight years from 1869 to 1876. According to the report of Dr. Engel, Director of the Statistical Bureau of Berlin, the number of lives lost was as given in the second portion of the above table.

The population of Prussia is larger than that of England and Wales—25¾ millions against 24½ millions—but, on the other hand, thunderstorms are less frequent there than with us. Altogether, it will be rather under than over the mark to say that as many persons are killed by lightning in England as in Prussia, the loss of life amounting to over a hundred every year on the average.

The terrible losses, both of property and human lives, still occasioned by lightning, are the more lamentable as they are in nearly all cases the result of the grossest negligence. The negligence is threefold—namely, first, in not providing any lightning conductors at all; secondly, in not placing them in the right position, or in sufficient number to cover a given area; and, thirdly, in not having them regularly tested, so as to ascertain their constant efficiency. Of course, the first-mentioned cause of neglect is by far the most important. It is one alike astounding and baffling all search for a reasonable explanation. Every year brings its regular thunderstorms, more or less in number, and most of them accompanied by fatalities.* All see the terrible lightning flashing over their heads; all tremble before the approach of the awe-inspiring electric force, the mere touch of which brings instantaneous death, and yet but an excessively small number of persons make any efforts to protect themselves, their families and houses, against the electric fire from the clouds. Public buildings fare little better than private houses. Even some of the first cathedrals of England, such as Peterborough, have no lightning conductors whatever, while others, supplied with them, are insufficiently protected, as apparent to any competent observer. A glaring case of absence of protection against lightning is to be found at Windsor Castle, grandest of all the historic buildings of England, and residence of her sovereign. It may seem incredible, but

* Mr. G. J. Symons mentions that in two storms, in June, 1872, nearly two hundred separate accidents came under his own knowledge, causing the death of ten persons, and injury to thirty-three others. The lightning struck sixty houses, fifteen of which were burned down, and killed twenty-three horses and cattle, and ninety-nine sheep. "This is," truly remarks Mr. W. H. Preece, commenting upon the figures, "the imperfect record of only two storms. What must it be for the whole year?"

I can vouch for it as an actual fact, ascertained by myself on a quite recent visit, that several portions of the noble pile, among them St. George's Chapel, home of the illustrious Order of the Garter, and the adjoining Belfry Tower, overhanging the main street of Windsor town, are entirely unprovided with lightning conductors. On other parts of the Castle a few conductors are placed, but clearly not enough. It is needless to say that, speaking only of St. George's Chapel and the Belfry Tower, these splendid ancient structures, in their exposed situation, constantly touched by the storm-clouds that sweep up the valley of the Thames, are liable at any moment to destruction, with irreparable loss to the nation.

If the entire absence of lightning conductors is the most prevailing cause of the still exceedingly great number of casualties occasioned by lightning, that of ill-placed or insufficient conductors is another deserving much attention. The mischief done in this case is not only that the conductor gives a false security, but that, should the dwelling on which it is placed be struck by lightning, it leads to the belief that the wonderful scientific discovery of Franklin is nugatory, or at least uncertain in its action. Only on this ground can it be explained that there are still a great many persons with no faith in lightning conductors, who have heard, or read, of instances in which buildings provided with them have suffered from lightning. In all these instances, and they are, it must be confessed, rather numerous, a careful investigation of the whole facts and circumstances invariably shows that the lightning conductor was not at fault. On the contrary, it is absolutely and invariably certain in its action, provided that it be properly placed, not neutralised by other forces, and have a good "earth connection."

I now come to the third cause of neglect, which, though ranged as the last, is by no means the least. My argument is that lightning conductors ought to be at regular intervals, at least once a year, carefully inspected, and their efficiency tested by a galvanometer. The absolute neglect of this precaution which is now prevailing is, I believe, the cause of a vast number of casualties by lightning, inflicted upon buildings nominally protected by conductors. Exposed as they are to all the destructive influences of wind and weather, and the often still more pernicious assaults of ignorant workmen, masons, bricklayers, and others, who, while undertaking repairs, tear down ruthlessly, as a nuisance, the wonderful yet fragile string of metal which leads the electric flame on its path, it but too frequently happens that persons who have had the wisdom to erect lightning conductors over their houses, and believe themselves fully protected, are in reality far worse off than being without a conductor. But utter neglect of the conductor, when once it has been put in its place, is the commonest thing, and indeed the rule, as regards private dwellings; and, I fear, there is little difference in this respect as to most public buildings, churches, and chapels. In fact, it is the old case of a matter, however consequential, yet being utterly disregarded as "nobody's business." Other repairs to all sorts of public buildings are regularly executed: the walls are kept safe; painting and whitewash are renovated from time to time; the roof is preserved watertight; and the turret-clock, if there is any, is thoughtfully looked after, oiled, cleaned, and repaired. But who is there that ever inspects the half-hidden little thing on which the safety of the whole fabric against the destructive effects of lightning depends? I made a great many enquiries on this highly important subject, and the more I did, the more I was surprised at the profound negligence generally prevailing about it. Between three and four thousand pounds were spent in protecting the Houses of Parliament by lightning conductors at the time of their erection, some twenty years ago. Since that time, as far as I can learn, after minute investigation, they have never been tested, and there is no guarantee whatever that a discharge of lightning may not at any time fall upon the Queen's throne, the Lord Chancellor's woolsack, or the Speaker's chair. As regards Windsor Castle, already referred to, the case is even worse. While parts of it are entirely unprotected, it is excessively doubtful whether the few conductors placed upon some of the

eminences of the vast range of buildings are at all efficient, and not merely "a delusion and a snare." It is well known that the all-important matter in respect to a lightning conductor, and the principal element of its efficiency, is the "earth connection," that is the immediate and complete dispersion of the electric force, after it has made its way from the clouds through its metal path, in the ground below. Moist earth is indispensable for the purpose, and I am very sceptical as to whether the few rods that stand over the Queen's private apartments at Windsor Castle, and the culminating mass of stonework—the Round Tower—actually have their root in moist earth. If not, it would certainly be better if the things were taken away altogether, and the whole magnificent structure treated like St. George's Chapel and the Belfry Tower. A French writer pithily expresses the results that follow from a lightning conductor over a house not having a proper "earth connection," by saying it is lightning guided to the owner's iron bedstead.

Having drawn attention to the chief causes of the numerous and fatal casualties caused every year by lightning, I have only to add a few words of advice as to how they might be prevented, or at least greatly diminished. First of all, I think it most desirable that public recommendation should be made, by local and other authorities, to place lightning conductors on all exposed or high-lying buildings, whether public or private, as well as on those standing near woods and on moist ground. It might be well worth the trifling expense to place simple conductors also against trees in parks, under which there are benches, or where persons are likely to gather during a thunderstorm, they forming a prolific source of fatal accidents. Above all, no church, chapel, school, prison, or other large public building, ought to be without one or more lightning conductors. There can be no excuse whatever for omitting this simple protective means against death and destruction, which may come at any moment, in the case of edifices devoted to public or national uses. But if it is necessary to greatly multiply lightning conductors, it is equally so that they should be planned and erected by competent persons, with scientific as well as practical knowledge of the work. There are a hundred circumstances which ought to be taken into account in selecting the best position for conductors, especially on large buildings and those of irregular construction; and only great experience, as well as cognition of all that we know about the movements of the electric force, can accomplish it. Of first importance are the considerations of the general design of the building that is to be protected; the soil on which it stands, whether dry or moist; the presence of masses of metal in or near the roof or the walls, as in the case before mentioned; the position of the chimneys; and similar matters affecting the course of the electric discharge of the clouds. It would be quite impossible to lay down absolute rules on the subject; still protection against lightning may be effected with the greatest certainty, under the guidance of well-known facts and observations which throw light upon the undeviating path of that mysterious electric force. But if everything possible has been accomplished towards the erection of the most perfect lightning conductor, there still remains something to be done. It is, not only to construct a faultless conductor, but to maintain it always in good condition. This is a matter which, sadly neglected, and overlooked to an astounding degree, cannot be too much insisted upon. It ought to be universally known that a lightning conductor is worth nothing unless it is periodically tested. The testing should take place at regular intervals, perhaps best in the spring, before the advent of the summerly thunderstorms, and it should likewise be made whenever a building has been undergoing repairs which may have damaged the conductor. A well organized system of inspection of lightning conductors would be most inexpensive. The galvanometer used for the purpose has been latterly much improved in Germany, and small portable instruments, of the size of a diminutive carpet bag, are now made, which leave nothing to be desired in the way both of effectiveness and durability. As the clocks in churches and other public buildings are methodically inspected by the clockmaker, so ought every lightning conductor to be as

systematically examined by an electrician or other competent person. Already such a system of inspection and testing of conductors exists in Paris and several other French towns. Shall we say, once again, "They manage these things better in France."

REPORT OF THE COMMITTEE ON ATMOSPHERIC ELECTRICITY.

The report stated that the committee has purchased three electrometers. These have been given—one to Surgeon-Major Johnson in India; the second to Mr. Michie Smith in India; and the third to Dr. Grabham in Madeira. Surgeon-Major Johnson was engaged in the frontier war in India; and Dr. Grabham has hitherto been too much occupied to make observations; while Mr. Michie Smith has not yet had time to furnish any; so that up to the present time no observations have been received. The committee feel confident of obtaining results from Mr. Smith, and hope also to receive reports from the other observers, but in the event of their being unable to furnish regular observations, the committee would get the electrometers back, and make them available for other persons.

SUN-SPOTS AND RAINFALL.

BY C. MELDRUM, F.R.S.

The conclusion at which the author arrived from a great number of observations in all parts of the world was that the maximum and minimum rainfall apparently coincided with the maximum and minimum sun-spots respectively.

THE TEMPERATURE OF THE EARTH WITHIN.

Mr. W. Morris read a paper on this subject. He held that the present method of determining underground temperatures with the thermometer as used in air or water was quite unsatisfactory. He suggested the employment of pairs of chronometers, one of each pair to be placed at the bottom of a bore, and the other at the surface, so that by the difference of their rates the mean temperature might be accurately ascertained.

ON CERTAIN PHENOMENA ACCOMPANYING RAINBOWS.

Professor Silvanus P. Thompson narrated several instances of rainbows, chiefly seen in Switzerland, when radial streaks of light, devoid of colour, were observed within the primary bow, and without the secondary bow. The explanation of these convergent rays was suggested by analogy with the divergent beams that are often seen breaking through the clouds at sunset!

REVIEWS.

Sanitary Examinations of Water, Air, and Food: a Handbook for the Medical Officer of Health. By CORNELIUS B. FOX, M.D., &c. London: Churchill. 8vo, 19–508 pages.

A CONSIDERABLE portion of this work lies beyond the field of criticism for this journal, and though very interesting and very useful, we are bound to pass it by. Meteorology and sanitary matters are, however, inseparable, and it is therefore natural that a considerable portion of Dr. Fox's work should be devoted to Meteorology. Dr. Fox is well known as the author of the best book upon Ozone in any language: his position, therefore, renders the following paragraph as important as it is amusing:—

"It was formerly the practice to employ starch tests, which are composed of a mixture of iodide of potassium and boiled starch, which became blue on

exposure to the air from the formation of the blue iodide of starch. There are many different kinds, which may be looked upon now as curiosities—for example: Schönbein's, Lowe's, Jame de Sedan's, Lender's, Moffat's, &c. They are all more or less disposed to play mad pranks; now they colour, then they bleach; sometimes they tint in a uniform manner; at other times they become marked with lines, like a Scotch plaid, or with spots; whilst they very frequently fade. Hence the records of observations appear most contradictory, forming a mass of almost inextricable confusion. In support of this assertion, the opinions of a few who have made ozone a subject of study may be quoted.

"'At the present time the modes of determining ozone, and the tests for ozone in the external air, are very unsatisfactory.'—*Dr. Richardson.*

"'The greater part of the countless observations on the amount of ozone in the air are worthless.'—*Professor Heaton.*

"'The determinations which have hitherto been made are very vague and unsatisfactory.'—*Dr. Wetherill.*

"'Tests prepared from the same recipes by different persons give varied results.'—*Boehm.*

"'If we expose the tests of Schönbein and Moffat together we do not get the same result, and even tests made by the same persons at two different times will not read alike.'—*Mr. Lowe,* of Nottingham.

"'All the methods employed are more or less defective.'—*Dr. Scoresby-Jackson.*

"'Until more certain means are discovered for estimating ozone, present observations must be received with great caution.'—*Davies.*

"'The estimation of ozone is in a very unsatisfactory state. The great imperfection in the tests makes it desirable to avoid all conclusions at present.'—*Professor Parkes.*

"'No clear and consistent results have yet been obtained. Variations of light, wind, time and paper may cause changes attributed only to ozone, and there are no reliable means of checking them.'—*Admiral FitzRoy.*

"'No trustworthy observations on ozone are made in the United States of America.'—*Dr. Henry,* of the Smithsonian Institution."

The relations between meteorology and disease are fully detailed, chiefly on the basis of the researches of Mr. Buchan and Dr. Mitchell.

Part IV. is entitled "Mode of observing Meteorological States and Variations in the condition of the Air"; it occupies nearly 50 pages, is fully illustrated, and very useful. We shall probably render the greatest service by picking out statements with which we do not agree.

Respecting the thermometer attached to the Fortin barometer, Dr. Fox says "the bulb of its attached thermometer should always enter the cistern." We thought that this old notion had long been dissipated. The attached thermometer is needed to tell us (1) the temperature of the scale upon which the barometer inches are marked, and (2) to tell us the temperature of the column of mercury in the barometric tube. Both of these data are more accurately given by a thermometer halfway up the brass tube and opening directly to the barometer tube, than by the old plan of burying the bulb in the cistern.

On p. 367 Dr. Fox sketches and describes a form of thermometer stand as the "Meteorological Society's Stand," but the Society have had all their stations provided with Stevenson's pattern, and the modification of Stow's represented by Dr. Fox is quite a rarity. We believe, however, that it is quite as good as a Stevenson.

Dr. Fox is very severe upon the inaccuracies of thermometers, and we do not object to severity upon such a subject, but we believe that

nearly all the faults quoted are explainable by his own statement of "the tendency which thermometers have to read higher from age."

With respect to Dr. Prior's criticism on clinical thermometers, as quoted by Dr. Fox, we bring together two sentences, which are separated by about a page :—

"Dr. Prior, of Bedford, in a paper on 'The Thermometer in Disease,' read before the South Midland Branch of the British Medical Association in 1867, relates an experiment of comparison which he made with five thermometers, three of them being medical instruments. He placed them all in water at a temperature of 105° or 106°, and allowed it gradually to cool. The result is here given in his own words: 'No two of them precisely corresponded at any time.'

* * * * * * *

"It is not by any means an easy matter to verify thermometers with precision. The verification can only be satisfactorily conducted by means of instruments specially adapted for the purpose, such as are to be found in the great observatories."

Dr. Prior's criticism is, therefore, valueless unless he possessed proper testing apparatus. If he had used such apparatus he would surely have mentioned it.

The chapter on Atmospheric Electricity is worthy of especial praise.

The Fenland, Past and Present. By S. H. Miller, F.R.A.S., and S. J. B. Skertchly, F.G.S. Wisbech: Leach & Son, 1878. Royal 8vo, 32–650 pp.

Enquiries were rather frequent as to when "The Fenland" really would be published; those who have now obtained this handsome volume—token in itself of what Fenmen can do—will feel that while they were waiting, the book was growing and improving. Now that it is finished it is permissible to suggest that the next edition will be handier in two volumes, and that it might be better to throw all the history, ethnology, and archæology into one volume, and the geology, meteorology, botany, and natural history into the other. However, we have to deal with the book as it stands, and with the exception of a few lines we must confine our attention to the meteorological portion. In these general remarks we unhesitatingly affirm that the work is crammed with information, creditable to all concerned in its production, and will be indispensable to all future writers upon the subject. But we have also a fault to find. Out of 682 pages not one is devoted to Fenland Bibliography. Even if the authors had only collected into one page a list of their predecessors, to whom they refer in various footnotes, it would have been useful; but we believe that they could have done far more than that, and we trust that they will commence such a catalogue in readiness for their next edition.

As would naturally be expected, the chapter devoted to Meteorology, written by Mr. Miller, is long and good. It is, in fact, a summary of 15 years' regular observations at Wisbech, with the addition of abstracts of extra experimental researches on Solar Radiation, Evaporation, and other subjects. We are not going to write a long panegyric upon Mr.

Miller's devotion to his observations, or on the ability he has displayed in working them up. An observer with a reputation is expected to do such things, and we take it as a matter of course; and all our readers know perfectly well that for the best information as to Wisbech climate they must look to Mr. Miller, and we have said already that the chapter upon the subject is good. It is needless to say that it is not perfect, and it is our duty to point out in what respects.

First, then, we are puzzled by the following statement on page 232:—

"THE TEMPERATURE.—The *amplitude* of the monthly mean was 24°·1 in 15 years."

Mr. Miller seems to use the word "amplitude" where meteorologists generally use the word "range"; but we cannot make the figures right: the hottest month (July, 1868) had a mean temperature of 66°·9, the coldest (December, 1874) of 31°·5, the extreme range was, therefore, 35°·4. We thought that it might indicate the *average* range, but according to Table IX. that works out 27°·1. Perhaps 24°·1 is a misprint for 27°·1.

We do not remember ever seeing a table of prevalence of fog, and are greatly astonished at the figures given in the present work. During November, December, and January there are on the average only two days with fog in each month! This is very droll; why instead of going to the Mediterranean to avoid the English November fogs one need only go to Wisbech; there will not be one foggy day in a fortnight.

The rainfall data are given very fully, and a few introductory remarks comparing the Fen values with those for other parts of the country render the subject easily followed by those previously unacquainted with it. The table of heavy falls in 24 hours is especially useful. On p. 237 "Honington" should be "Honingham"; most people would, however, recognize it as Lady Bayning's valuable station near Norwich.

Mr. Miller will, we hope, forgive us for treating as a scare-crow a paragraph in which he has committed no greater offence than that of following all the highest living authorities. The following is the paragraph:—

"The *elastic force* or *tension of vapour* is an expression of the statical force which vapour exerts on a column of mercury. As an illustration, suppose the barometer reading to be 29·9 inches and the *tension of vapour* at the time of observation 0·4 inch; then if all the vapour were withdrawn from a column of air extending throughout the atmosphere, the barometer would read 29·5 inches, and would thus represent the weight of a column of *dry* air. The *elastic force* is a measure of the *absolute* amount of vapour in the air."

Suppose balloons had not been invented, even then would or could anybody believe that the air at heights of 1, 2, 3, 4, 5, &c. miles is always in exactly the same hygrometric condition as the layer which is 4 ft. above the ground? Would anybody suppose that it is the same at 4, 40, 400, 4,000, and 40,000 feet? Besides, thanks to Mr. Glaisher, we now know that such a thing as a uniform hygrometric

condition from the earth's surface to the altitudes which he alone has reported upon never exists.

We have two instruments—one, the barometer, tells us the total weight of the atmosphere above it; the other, the hygrometer, tells us how much moisture there is in the air immediately surrounding it. This amount of moisture may be legitimately described either as the per centage of the total capacity of the air for holding moisture which is shortly expressed by the term "relative humidity," or it may be expressed as "elastic force" *at the place of observation*, but we cannot understand how any one can regard this value as indicative of the hygrometric condition of the atmosphere at a height of two or three miles. As we cannot know that the entire atmosphere above the barometer is in the same hygrometric state as prevails around the hygrometer, we regard all such definitions of elastic force as that given above as delusions and snares, as fictions with only a slender substratum of fact. If we are wrong we shall be delighted to be put right, but if we are not wrong we hope that an accurate definition of the term elastic force will be given.

Why will authors use grand words instead of those to which readers are accustomed? Meteorologists know that Mr. Miller has devoted much time and money to experiments upon evaporation; his heading of the subject is "Evaporation," and yet in the third line he tells us that "In the atmosphere of our globe two great processes constantly obtain, namely, *vaporization* and *condensation*." We have nothing to do with philology, and our stock of English dictionaries is limited, but Nuttall defines "Vaporization—artificial formation of vapour." We leave Messrs. Miller and Nuttall to settle whether "Vaporization" means the natural or the artificial formation of vapour. This, however, is a by-shot, and we are glad to conclude by saying that the section contains much entirely new information, especially respecting the evaporation from water, soil, peat, long grass, short grass, and red and white clover; also from sunflowers, cabbages, &c.

Sanitary Engineering: a Guide to the Construction of Works of Sewerage and House Drainage. By BALDWIN LATHAM, M.I.C.E., &c. 2nd edition. London and New York: E. & F. N. Spon. 32–559 pages, 8vo.

THERE are two reasons why we should not notice this book—(1) because it is rare for reviewers to mention second editions, (2) because it is not a strictly meteorological work. But there are stronger reasons for calling attention to it. We believe it to be by far the best book upon the subject, and it is virtually a new work, for it is two or three times as large as the first edition, which, by the bye, having been rapidly exhausted has led to copies being obtainable at only fancy prices. Though not a meteorological work, it is one which is largely dependent on meteorologists, for, as Mr. Latham truly observes,

"rainfall tables are of great importance and inestimable value to the engineer in designing works of sewerage."

The historical notes on the drainage arrangements of the Jews, Greeks and Romans are very interesting. With reference to the latter we would advise Mr. Latham, when he can get an idle day, to run down to Silchester and examine the remarkable revelations of Roman life which are coming to light under the direction of the Duke of Wellington.

Before concluding, we wish to call attention to the fair and honourable way in which Mr. Latham gives to everyone the credit for what each has done. Some persons appear to think that by ignoring the old motto, *Palmam qui meruit ferat*, they induce their readers to suppose that they are individually the *fons et origo* of all the knowledge afforded by their books. We think that they make a terrible mistake, and that with quotations, as with everything else, "honesty is the best policy."

RATIO OF MAXIMUM DAILY TO MEAN YEARLY RAINFALL.

To the Editor of the Meteorological Magazine.

SIR,—Having for a long time held the opinion that the greatest amount of rainfall in any one day bears a direct ratio to the mean annual fall, I some years ago constructed a table for my own use in discussing the amount of flood water passing down the streams.

Lapse of time having shown it to be as accurate as anything based upon the eventualities of weather can be expected to be, and in the hope that it may be useful to some of your readers, I shall be glad if you can find a corner for its insertion.

Average Annual Fall.	Max. Fall in one day.	
Inches.	Per cent. of Annual Fall.	Amount Inches.
20	20	4·0
25	18	4·5
30	16	4·8
35	14¼	5·0
40	13	5·2
45	12	5·4
50	11	5·5
60	10	6·0

Its practical bearing on Meteorology is to show that if a rain-gauge, read only once daily, does not hold the quantity shown in the third column, depending upon the mean annual fall at the place in question, a time will come when it will be filled to overflowing, with consequent loss of the register.—I am, Sir, yours faithfully,

EDWARD M. EATON, A.I.C.E., F.M.S.

Water Works Office, Sheffield, 5th October, 1878.

[WE are extremely glad to receive the above letter for several reasons, of which, however, we need only mention two or three. It

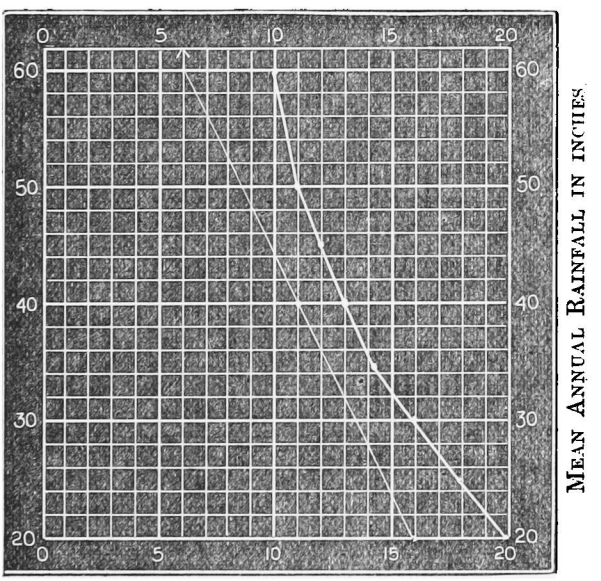
is always satisfactory when two computers working unknown to each other, and on different data, arrive at analogous results. The subject investigated by Mr. Eaton was mentioned eleven years ago in *British Rainfall*, 1867, on p. 79 of which work the following paragraphs will be found :—

"The extreme per-centage of the mean annual rainfall which may be expected on any one day is, with a mean fall of 20 inches, 16 per cent. ; the per-centage decreases 1 per cent. for each additional 4 inches of mean fall, until it falls to 6 per cent., and above that point (60 in.) it is constant at 6 per cent., whatever the mean fall may be.

Examples.	Mean Fall.	Per-Centage.	Computed Max.	Observed.
Retford ...	22 in.	15·5	3·41	3·10
St. Agnes..	42 ,,	10·4	4·41	4·00
Seathwaite	140 ,,	6·0	8·40	6·62

"The result of this rule is that there is no part of the British Isles where a fall of from 3 to 4 inches of rain in 24 hours will not occur, sooner or later. Wherefore observers are requested to ascertain the capacity of their rain gauges, and if they find it three inches or under, to provide themselves with one of larger storage."

Mr. Eaton's values and those given by Mr. Symons in the above quotation are shown on the following diagram, and, for reasons which



PER-CENTAGE OF MEAN ANNUAL AMOUNT WHICH WILL FALL ON ONE DAY.

it would require too much space to explain fully, we have little doubt that Mr. Eaton's are nearer the truth than the others. But whichever is adopted there is one conclusion which is unavoidable, namely, that

observers should pay strict attention to Rule XVI., which is as follows :—

"XVI.—OVERFLOW.—It would seem needless to caution observers on this head, but as a recent foreign table contain *six instances on one day* in which gauges were allowed to run over, it is evidently necessary that British observers should be on the alert. It is not desirable to purchase any new gauge of which the capacity is less than four inches." —ED.]

SUPPLEMENTARY TABLE OF RAINFALL IN SEPT., 1878.

[For the Counties, Latitudes, and Longitudes of most of these Stations, see Met. Mag., Vol. X., p. 28., but the list is under revision.]

Div.	Station.	Total Rain.	Div.	Station.	Total Rain.
		in.			in.
II.	Acol	1·23	XI.	Castle Malgwyn	4·08
,,	Littlehampton	1·97	,,	Nantgwilt, Rhayader	4·81
,,	Hailsham	1·41	,,	Carno	3·73
,,	St. Lawrence, I. of W.	2·08	,,	Rhug, Corwen	2·12
,,	Strathfield Turgiss	·69	,,	Port Madoc	4·05
III.	Addington Manor	1·13	XII.	Carsphairn	6·36
,,	Oxford	1·49	,,	Melrose	3·31
,,	Northampton	2·24	XV.	Gruinart	4·83
,,	Cambridge	·75	XVI.	Grandtully	...
IV.	Sheering	1·02	XVII.	Tomintoul	2·82
,,	Diss	1·32	,,	Keith	2·67
,,	Swaffham	1·87	XVIII.	Dalwhinnie	8·29
V.	Alderbury, Salisbury	1·54	,,	Auchnasheen	7·82
,,	Compton Bassett	1·49	,,	Springfield, Tain	1·96
,,	Dartmoor	4·91	,,	Glenfinnan	16·17
,,	Langtree, Torrington	4·27	XIX.	Watten	3·66
,,	Cosgarne, St. Austell	4·59	XX.	Glenville, Fermoy	3·38
,,	Taunton	...	,,	Tralee	3·69
VI.	Bristol	2·43	,,	Tipperary	3·57
,,	Sansaw	2·74	,,	Newcastle W., Limerick	2·99
,,	Cheadle	2·81	,,	Kilrush	3·92
,,	Bickenhill Vicarage	2·75	XXI.	Kilkenny	2·32
VII.	Coston, Melton Mowbray	1·27	,,	Kilsallaghan	2·28
,,	Bucknall	1·60	,,	Twyford, Athlone	4·12
VIII.	Walton, Liverpool	4·02	,,	Belvedere, Mullingar	3·95
,,	Broughton-in-Furness	5·95	XXII.	Ballinasloe	3·37
IX.	Stanley, Wakefield	2·49	,,	Kylemore	10·52
,,	Mickley, Ripon	2·35	,,	Carrick on Shannon	3·54
X.	Gainford	2·36	XXIII.	Rockcorry	4·29
,,	Unthank Hall	3·57	,,	Warrenpoint	3·04
,,	Shap	5·88	,,	Newtownards	2·80
XI.	Llanfrechfa	4·58	,,	Bushmills	4·66
,,	Solva	1·69	,,	Buncrana	4·10

SEPTEMBER, 1878.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Greatest Fall in 24 hours. Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Max. Date.	Min. Deg.	Min. Date.	No. of Nights below 32°. In shade.	No. of Nights below 32°. On grass.
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	·83	— 1·43	·21	17	12	75·4	7	37·7	24	0	0
II.		Maidstone (Hunton Court)	·87	— 1·25	·29	19	9	...	...	...	...	...	...
,,		Selborne (The Wakes)	1·64	— ·80	·48	17	11	70·0	6, 8	31·0	24	2	...
III.		Hitchen	·96	— ·90	·20	17*	12	68·0	5	37·0	23	0	...
,,		Banbury	1·77	— ·60	·62	7	15	72·5	5	31·0	24	1	...
IV.		Bury St. Edmunds (Culford)	1·40	— ·21	·39	8	14	74·0	5	33·0	20	0	2
,,		Norwich (Sprowston)	2·72	...	·59	12	17	...	...	...	...	...	...
V.		Bridport	2·07	— ·25	·67	22	10	...	...	...	...	...	...
,,		Barnstaple	4·03	+ ·27	·80	22	16	78·0	6	46·0	23	0	...
,,		Bodmin	3·14	— ·53	·83	22	15	76·0	5	46·0	23	0	0
VI.		Cirencester	1·73	— 1·13	·40	19	10	...	...	...	...	...	...
,,		Shifnal (Haughton Hall)	3·03	+ 1·08	·66	8	15	70·0	5	35·0	24	0	1
,,		Tenbury (Orleton)	3·66	+ ·98	1·00	22	14	73·5	5‡	32·8	26	0	3
VII.		Leicester (Town Museum)	1·82	...	·45	7	14	70·3	3§	33·6	24	0	5
,,		Boston	1·57	— ·00	·29	12†	13	77·0	7	38·0	24	0	...
,,		Grimsby (Killingholme)	2·72	..	·42	29	16	68·0	3‖	40·0	21¶	0	...
,,		Mansfield	1·54	...	·32	22	14	71·8	4	35·5	24	0	0
VIII.		Manchester (Ardwick)	3·48	+ ·30	·90	17	15	71·0	6	40·0	24	0	...
IX.		York	2·67	— ·34	·47	25	10	73·0	11	36·5	21	0	1
,,		Skipton (Arncliffe)	6·63	+ 1·67	1·65	22	23	72·0	4	32·0	20	1	...
X.		North Shields	1·68	— ·02	·48	15	14	65·0	7	45·0	21**	0	0
,,		Borrowdale (Seathwaite)	15·06	+ 1·85	2·18	15	20	...	...	...	...	..	...
XI.	WALES.	Cardiff (Crockherbtown)	3·21	...	1·28	22	9	74·3	5	40·0	26	0	...
,,		Haverfordwest	3·24	— ·47	·62	22	12	73·0	5	38·0	25	0	...
,,		Aberdovey	3·39	...	·75	22	18	80·0	11	43·0	21¶	0	0
,,		Llandudno	3·75	+ 1·41	·71	29	16	73·2	5	43·0	24	0	...
XII.	SCOTLAND.	Dumfries (Crichton Asylum)	3·20	+ ·26	·97	23	18	71·2	5	37·0	20††	0	...
,,		Hawick (Silverbut Hall)	2·90	...	·70	15	17	...	...	...	...	...	...
XIV.		Glasgow (Cessnock Park)	4·80	+ 1·73	1·30	29	20	...	...	...	...	...	...
XVI.		Mull (Quinish)	6·58	..	1·08	15	25	...	...	...	...	...	...
,,		Loch Leven	4·00	+ ·97	1·20	30	13	...	...	...	...	...	..
,,		Tyndrum (Ewick)	...	...	...	...	...	..	...	...	...	...	...
,,		Arbroath	3·34	+ ·82	1·11	29	14	71·0	6	39·0	26	0	...
XVII.		Braemar	5·03	+ 2·39	1·04	15	15	68·8	5	34·0	28	0	5
,,		Aberdeen	3·32	...	·99	29	19	72·1	3	38·7	26	0	0
XVIII		Gairloch	6·00	...	·85	29	19	...	...	...	...	...	...
,,		Portree	10·55	— ·21	1·79	15	23	..	...	...	...	...	...
,,		Inverness (Culloden)	2·89	+ ·20	·75	30	18	71·9	5	39·9	21	0	0
XIX.		Dunrobin	4·53	+ 1·76	·87	15	19	70·0	5	38·0	27‡‡	0	...
,,		Sandwick	5·90	+ 2·24	1·18	24	22	65·0	8	42·6	21	0	0
XX.	IRELAND.	Caherciveen Darrynane Abbey	4·70	...	·73	20	23	...	...	...	...	...	...
,,		Cork	3·15	...	1·50	22	13	...	...	...	...	...	...
,,		Waterford	2·48	— ·65	1·18	21	15	74·0	5	34·0	21	0	...
,,		Killaloe	4·46	+ ·30	·66	21	19	80·0	6	34·0	23	0	...
XXI.		Portarlington	3·17	— ·11	·86	21	28	71·0	5	37·5	20	0	..
,,		Monkstown, Dublin	1·70	— ·29	·57	29	13	...	..	...	...	...	...
XXII.		Galway	3·65	..	·55	16	23	72·0	8	40·0	23	0	...
XXIII		Waringstown	3·24	...	·85	29	18	75·0	5	38·0	22	0	...
,,		Edenfel (Omagh)	....	...	...	...	...	...	...	...	...	..	....
,,		Ballyshannon	5·66	...	·80	24	18	...	..	...	...	...	...

* And 22. † And 29. ‡ And 6, 11. § And 6, 7. ‖ And 4, 5, 9, 14.
¶ And 24. ** And 26. †† And 21, 22. ‡‡ And 30.
+ Shows that the fall was above the average; — that it was below it.

METEOROLOGICAL NOTES ON SEPTEMBER.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; TS for Thunderstorm; R for Rain; H for Hail; S for Snow.

ENGLAND.

SELBORNE.—A fine month for concluding the harvest and for hop-picking. Prevailing wind westerly; T & L on 8th; L on 23rd.

BANBURY.—High wind on 15th, 29th and 30th. T & L on 7th and 29th.

CULFORD.—Mean temp. of month 55°. Easterly wind on one day only, high wind from S.W. 15th to 18th. TS on 8th, and a severe TS about 6.30 a.m. on 30th, when a block of three cottages in the village was struck by L, and much shattered, the inmates fortunately escaping.

SHIFNAL.—Dry with one exception till the 8th, when there was a TS with heavy R, during a thick fog. From that day fine till the 15th, when R fell in the afternoon, followed by high wind at night from S.W., veering as usual to W. and N.W., and lasting the next day. On 22nd, heavy R again at night, and T and H at 2 p.m. on 23rd, from which date R fell daily with two exceptions till the close. Partridges very deficient, the eggs having been destroyed by the R in May. Still only a few red admiral and tortoisehell butterflies.

ORLETON.—Several heavy falls of R during the month, which kept the land in a very wet state. In the intervals the weather was tolerably fine, and the temp. steady. Mean temp. nearly 0°·5 below the average; L and T early on the mornings of the 8th and 30th; and distant T on the 23rd. Strong wind on the 15th, 17th, 22nd and 30th.

LEICESTER.—Thunderstorms on the 8th and 30th.

BOSTON.—Harvest finished about the 14th, after a long and tedious ingathering, the quantity much below the average, and the quality very bad. The wheat seed was well got in during the dry weather of last autumn, and the season was favourable till May, which was wet and cold; the beginning of June was cold, the temp. on the night of the 15th falling to 38°. After this a period of bright warm weather set in, which completely restored the colour of the plant, and it was in ear about the 17th; the 26th of June and two following days were exceedingly hot, and the sun was very scorching, the max. in shade reaching 88°. A day or two afterwards a complete change occurred, the max. temp. of July 1st being 65°, a fall of 18° in two days, the temp. continued to fall, the lowest point (45°) being reached on the 4th; this sudden change of temp. affected the maturing of the plant at a critical time, and caused a great many blind ears. During August, while harvesting was going on, R fell on 18 days, which mildewed the corn and caused a great deal of sprouting, the wheat when finally harvested being in very bad condition. TS on 30th. Saturday, 28th, a.m., a very high tide, 15ft. 10in. above ordnance datum; wind very calm.

GRIMSBY.—First half of month fine and dry, the latter just the reverse. Horse flies extremely troublesome, and red admiral butterflies more abundant than usual. Faint T on 8th; TS on 30th. Harvest finished on 14th; stormy on 15th and 16th. High tide in Humber on 28th, but, being calm, no damage was done.

MANSFIELD.—Strong wind on 15th; T about 4 a.m. on 30th.

YORK.—Primroses in blossom by the middle of the month. Gale on 15th; T on 30th.

WALES.

ABERDOVEY.—Fine genial weather up to the 15th, when there was an evident change, as from that date it was more or less unsettled and stormy, although exceedingly mild throughout. T and L on the night of the 30th.

LLANDUDNO.—The first 14 days were fine, calm, and comparatively fair; but from the 15th to the 19th the weather was stormy, and the last day of the month was a thoroughly wet one. Mean temp. about the average.

SCOTLAND.

HAWICK.—Fine harvest weather up to the night of the 14th, when a hurricane set in from the W., doing much damage during the three days it lasted. The most beautiful lunar rainbow ever seen here was witnessed on the night of the 18th. The sky was almost entirely obscured by clouds; in the west there was a continuous bank of dark nimbus, over which the rainbow stretched. Seen from the Common Haugh, one limb seemed to rest on the Crumhaugh hill and the other on the Borthaugh hill. In the east the clouds were broken up, and as the moon appeared and disappeared between the rifts of clouds, the rainbow came and went. This continued for a considerable time, but after a heavy downpour of R it was no longer seen.

QUINISH.—A wet, unsettled month. Tremendous gale from S.W. to W. on 15th and 16th, with extraordinary R, from 9.30 to 10.30 a.m. on 15th.

BRAEMAR.—A very excellent month; crops all secured in first rate condition at an earlier date than for some 20 years. A violent hurricane on 15th.

ABERDEEN.—A month of rather fine warm weather; mean temp. 54°·9, 1°·4 above the 21 years' mean.

DUNROBIN.—Month, on the whole, fine and favourable for harvest operations. Gale from W. on 15th, 16th and 17th, many trees blown down.

SANDWICK.—A pleasant month till the 15th, when the barometer fell at midnight to 28·440 in., and immediately afterwards our equinoctial gales began blowing 50 miles or more most of the 16th, and 60 miles from 1 to 2 p.m. There was another gale of 50 miles an hour, from 6 a.m. till noon on 18th, doing much injury to that part of the crops that was uncut.

IRELAND.

DARRYNANE.—Another bad harvest month, constant small R with heavy showers at intervals. Wind almost constantly from W.

KILLALOE.—Weather not very favourable for finishing harvesting, but mean temp. high.

MONKSTOWN.—A very seasonable mouth, some days very cold. The extreme end of the month very fine and warm. A slight frost on the morning of the 21st. Very heavy R with L and T on night of 29th.

WARINGSTOWN.—Very fine, warm and favourable for securing harvest until the last week. Crops secured in prime order.

BALLYSHANNON.—The month was marked by heavy rains and gales of unusual violence. On the 14th, a heavy gale from S., breaking down and uprooting trees and shrubs. Bar. fell suddenly to 29·22. On 15th, T and L; 16th and 17th, storm from W., with unusually high tides and hail showers.

THE WEATHER IN SEPTEMBER.

During the first week of September the changes in pressure were gradual and not extensive, no serious disturbance being recorded. For the first few days the weather was clear and bright, being a great improvement on the latter part of August; a good deal of fog, however, was recorded on most days from some places. In the first part of the week the area of highest readings was off our south-western coasts, and the lowest over the North Sea, so that N.W. breezes prevailed with low temperature. This distribution, however, gave way on the 2nd; the region of high readings during the succeeding few days passed slowly across France and our S.E. coasts and travelled on the eastern shores of the North Sea, whilst depressions passed northward along our western and north-western coasts, giving us southerly and south-westerly winds, with warm but rather showery weather. By the end of the week the area of high pressure was re-established over western France, the wind veered to the westward and temperature fell. Small amounts of rain

fell somewhere every day, and no thunderstorms of any importance were reported.

No important depression reached our coasts during the second week. On the 8th readings, though higher in the S.W. and lower in the N.W. than elsewhere, were very uniform generally, and light variable breezes prevailed. The next day there was a slight depression to the north-westward of Scotland, giving us fresh westerly winds; but this quickly passed away, and a large anticyclone lay over England, Ireland, and the north of France from the 10th to the 12th, very light airs prevailing over those countries, while breezes from the W. were reported in the north and from E. in the south. On the 12th the high pressure was again shown in the S.W., and a small disturbance, which advanced from the northward down our east coast, gave us a fresh northerly gale in the N.E. and a sharp squall elsewhere. On the 13th the bar. fell in the N. and W., and this fall extended to the whole of these islands on the following day. Readings highest over Brittany, lowest in the neighbourbourhood of Christiansünd; strong wind in south of Norway.

The third week opened with a very serious disturbance, a decrease of pressure of 0·8 in. had occurred during the night on our N.W. coasts, and over the whole of these islands the mercury was falling briskly. Readings were highest over France, and gradients were very steep. Wind was S.W. to W. on our coasts, and while strong generally, reached a fresh gale in the N. of Scotland and at Valentia. During the 16th the disturbance passed slowly away eastward, and hard westerly to north-westerly gales prevailed over the greater part of our islands. In its rear the barometer rose quickly, but the recovery was of short duration, for on the night of the 17th and morning of the 18th the barometer was falling everywhere, with strong westerly to south-westerly winds, and rainy weather over England. On the 19th the barometer rose everywhere except in Sweden, but in the evening it fell again in the south, though rising in the north. This change continuing, high pressures were established in the W. and N.W., and northerly breezes prevailed on our coasts, with a brisk fall of temperature, and fair, dry weather. On the 21st a large area of high pressure lay over England, Ireland and France; the weather was fine and bright generally, and the barometer rising with light breezes except at Valentia, where a fall had commenced with a south-south-easterly wind. This fall became brisker during the day and extended to all Western Europe, while the wind in the S. of Ireland rose to a fresh gale from S., with wet, gloomy weather, the change gradually spreading eastwards towards evening. The fall continued on the 22nd, except over Scandinavia and Denmark, the change in the west amounting to about half-an-inch. A large depression lay over the N.W. of Scotland, and a small subsidiary one to the S. of Ireland. At the same time the area of high readings was shown over North Germany; in consequence southerly winds, ranging from a light breeze to a fresh gale, prevailed over these islands. The depressions moved south-eastwards, and on the 24th, when the bar. was rising everywhere except in North Germany, the area of lowest pressure was shown in the S.E., while readings were relatively high over the Baltic, off the W. coast of Ireland and in the S.W. of France. On the 27th and 28th the bar. rose everywhere; an area of high readings lay over France, and pressure was very uniform over these islands. On the following day pressure increased somewhat in the N. and E., but decreased in the S. and W., and over France. On the 30th a well-marked depression advanced from W. to E. across these islands, while the bar. began to recover again in the W. and S.W. During the last ten days of the month the changes in temperature were considerable and frequent, and rain fell very generally.

W. E. M.